SYSTRON DONNER
A THORN EMI company

HR SERIES

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SYSTRON DONNER
Member THORN EMI Group

HR SERIES

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POWER SUPPLY DIVISION

POWER SUPPLIES

DOCUMENT NO. 120016-01

OPERATING AND SERVICE MANUAL

The HR Series Manual consists of:

HR20-12 COV
HR40-10 COV
HR60-8 COV
HR160-3 COV

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January 1982

SYSTRON DONNER
Member THORN EMI Group

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CHAPTER 1

DESCRIPTION

1.1 INTRODUCTION

The Medium Power Half Rack (HR) Series power supplies are flexible and dependable sources of DC power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes these units well suited for use as basic laboratory power sources. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems requirements.

This manual provides general characteristics and specifications, operating procedures, theory of operation, maintenance and troubleshooting, calibration, parts lists and related schematics for the Models HR20-12C OV, HR40-10C OV, HR60-8C OV and HR160-3C OV.

1.2 DESCRIPTION

The Half Rack Series units are designed for laboratory, bench, test, inspection, production and systems applications. Their unique design provides operating flexibility and high reliability at high power output levels.

1.3 GENERAL FEATURES

Automatic short circuit protection, remote voltage programming, remote sensing, front or rear, no turn on/turn off transients and overvoltage protection are all standard features in the Half Rack Series. Output, Sensing and Remote Programming terminals are located on a terminal board mounted on the rear panel of the unit. The AC power swtich, AC pilot lamp, current mode indicator lamp, current mode indicator lamp, current and voltage controls and appropriate metering devices are all located on the front panel. For convenience, additional output and sensing terminals have been provided on on the front panel.

1.3.1 Constant Voltage Mode

A constant voltage is maintained across the output terminals at any preset value from zero to rated voltage output, provided that the load does not draw more than either the rated output current or more than the preset limiting current value determined by the front panel current control settings.

1.3.2 Constant Current Mode

Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic crossover network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the preset current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions. The crossover point is adjustable, and can be established anywhere within the current and voltage range of the unit.

1.3.3 Automatic Current Limiting

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting occurs is variable, and may be selected anywhere between 1% of the rated current output and maximum rated current output of the unit. In the event of a short circuit, the output voltage will drop to zero, and will return to its previous level only upon removal of the short circuit.

1.3.4 Automatic Overvoltage Protection

Automatic Overvoltage (OV) protection prevents the output voltage from exceeding approximately 10% or 1.5 volts above the programmed voltage. An internal sensitivity control is provided to desensitize the OV protection circuit.

1.3.5 Remote Programming - Voltage Output (RVP)

Remote Programming is provided in the voltage mode of operation, and may be utilized over the entire voltage range of the unit. The scale factor for Remote Voltage Programming is 100 Ω per volt.

1.3.6 Remote Programming - Current Limiting (RIP)

Remote Programming is provided to set the current limiting point. The scale factor for Remote Current Programming is the inverse of 250 Ω. 0 ohm provides maximum rated current, 250 ohms provides minimum current.

1.4 PRECAUTIONARY MEASURES

1.4.1 Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from underrated or overloaded AC input lines. The maximum AC impedance from the breaker box to the power supply input should not exceed 0.75 ohms.

1.4.2 Voltage Regulator and Inverter Inputs

Do not use voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the power supply, will cause serious loss of regulation of the power supply output. Capacitive input filtering used for semiconductor power supplies requires charging to the peak of the rectified AC wave which nonsinusoidal AC sources may not provide.

1.4.3 System Considerations

In systems applications it is recommended that each power supply input power line be run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. Do not run sensitivie signal leads such as the remote sensing leads in the same cable as the AC input without shielding. To keep the AC ripple in the output to a minimum, it is recommended that AC input cables should not be run in close proximity to the output load cables.

1.4.4 Terminal Post Resistance

All terminals and shorting links serving Outputs, Sensing and Programming must be securely tightened before use. Serious loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links.

The specifications cited herein for regulation and ripple can be readily attained on every power supply supply providing the proper method of measurement is employed. The major consideration is that the highly stable meter and oscilloscope, specified in the calibration procedures, must be connected to the sensing terminals and not the load terminals. The reason for this precaution is that the voltage drop between the load terminals and sensing terminals will yeild an inaccurate regulation ripple measurement.

1.5 SPECIFICATIONS

Table 1-1 is a complete list of standard specifications for the Medium Power Half Rack Series.

TABLE 1-1 SPECIFICATIONS

ELECTRICAL SPECIFICATIONS	
Constant Voltage Mode with Adjustable Current Limiting	
Input:	105-125 VAC, 55-65 Hz (200-240 VAC, 50 or 400 Hz available).
Output:	Floating; isolated from ground, 300 VDC maximum.
Regulation, Line:	0.01% or 2 mV[1], for 105-125 VAC line change, at any output within specifications.
Regulation, Load:	0.01% or 3 mV[1], no load to full load at any output within specifications.

TABLE 1-1 SPECIFICATIONS (Cont'd)

ELECTRICAL SPECIFICATIONS (Cont'd)	
Ripple:	Less than 0.5 mV RMS, 15 mV p-p.
Stability:	0.05% or 18 mV[1] for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient:	(0.02% +400 μV)/°C.
High Stability (Option X):	0.01% or 2 mV[1] with a T.C. of (0.01% +100 μV)/°C.
Temperature Range:	-20°C to +71°C.
Recovery Time:	Less than 50 ms to recover within 0.05% or 15 mV[1] of output voltage for 25% step change in rated load.
Output Impedance:	DC - 1 kHz; 10 million ohms nominal.
Short Circuit Protection:	Automatic Adjustable Current Limiting (ACL) variable from 1% to 100% of rated current.
AC Power Input Protection:	Fuse.
Remote Programm Programming:	All units remotely programmed over output voltage range. Scale factor approximately 100 ohms/volt.
Remote Sensing:	Maintains rated regulation directly at the load. Maximum line drop 0.5V per leg.
Voltage Adjustment Range:	Continuously adjustable concentric vernier controls.
Overvoltage Protection:	Automatic fast acting overvoltage protection tracks the preset output voltage.
Constant Current Mode with Adjustable Voltage Limiting	
Current Range:	1% to rated current output.
Voltage Compliance:	0 to rated output voltage.
Regulation, Line:	0.5% I_{rated} for 105-125 VAC line change at any output within specifications.
Regulation, Load:	0.5% I_{rated} output current change for maximum change in load resistance within the rated voltage compliance range.

TABLE 1-1 SPECIFICATIONS (Cont'd)

ELECTRICAL SPECIFICATIONS (Cont'd)	
Ripple:	0.25% or 5 mA[1].
Stability:	0.5% I_{rated} for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient:	0.1% I_{rated}/°C.
Remote Programming:	$Rpgm = 250 \left(1 - \frac{1\ Load}{1\ Rated}\right)$
GENERAL AND PHYSICAL SPECIFICATIONS	
Operational Modes:	Constant Voltage w/adjustable current limiting; Constant Current w/adjustable voltage limiting; Automatic Crossover.
Mode Indicator:	Front panel mode indicator light indicates when supply is operating in the constant current or current limiting mode.
Controls:	
Voltage:	Coarse and Fine; 0 to rated output; front panel.
Current:	Coarse and Fine; 1% I_{rated} to rated output; front panel.
Input Power:	Front panel switch and indicator.
Metering:	
Voltage:	Front panel voltmeter.
Current:	Front panel ammeter.
Terminals:	
Front Panel:	Positive Output (+V); Negative Output (-V); Positive Sensing (+S); Negative Sensing (-S); Ground (G).
Rear Panel:	(1) Negative Output -V; (2) Negative Sensing (-S); (2-3) Remote Voltage Programming RVP; (4) Ground G; (5) Positive Sensing +S; (6) Positive Output +V; (6-7) Remote Current Programming RIP; (8-11) Spares.
Size & Weight:	7-3/4"W x 4-7/8"H x 14"D. 28 lbs.

[1] Whichever is greater.

CHAPTER 2

INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

2.1.1 General

If the Medium Power Half Rack Series power supplies are used in a portable bench type configuration, no special mechanical installation is required. However, if the units are rack mounted, special rack mounting adapters must be used to secure the units to the relay racks. Single (RPA-1) and dual (RPA-2) rack panel adapters are available.

2.1.2 Rack Panel Adapter Mounting

1) Remove the 6-32 screws which fasten the cover to the power supply chassis.

2) Remove and rotate the cover so that the front is now facing to the rear.

3) Fasten the cover securely in position with the 6-32 screws previously removed.

4) Attach the handles to the Rack Panel Adapter.

5) Stand the Rack Panel Adapter in front of the power supply. In order to mount the power supply properly, the top of the Rack Panel Adapter must face up. The top is distinguishable from the bottom in that all the holes, including those for the handles, are in a straight row across the front of the Rack Panel Adapter.

6) Place the Rack Panel Adapter against the front panel, so that the four holes in the adapter line up with the four holes in the front panel. Fasten the adapter to the front panel with four 6-32 x 1/2 screws.

2.2 ELECTRICAL CONNECTIONS

2.2.1 Input, Power

A heavy duty 3 wire line cord and molded plug with grounding prong provides a path for input power to the unit.

The power handling ability of the AC power lines feeding AC power to the line cord must be considered, as serious losses in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. The AC impedance from the breaker box to the power supply input connector should not exceed 75 Ω. All AC power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The figures listed in Table 2-1 will serve as a guide is making this selection.

TABLE 2-1 AC INPUT WIRE SIZE

LENGTH OF RUN (SINGLE LEAD)	WIRE SIZE (AWG STANDARDS)
10 feet of less	16
10 to 20 feet	12
20 to 50 feet	10

2.2.2 Rear Panel Output

An 11 terminal barrier strip mounted on the rear panel provides output, sensing, programming and ground connections. Table 2-2 Rear Panel Shorting Link Application, lists the varous shorting link connections required for any of the various modes of operation.

2.2.3 Front Panel Output

Five binding post terminals mounted on the front panel provide output, sensing and ground connections. Table 2-3 Front Panel shorting Link Application, lists the various shorting link connections required for these modes of operation.

2.2.4 Front or Rear Panel Output Selection

Local or remote sensing and regulation is available from either the front or rear panel terminals. However, to maintain regulation, only one set of terminals may be used at a time. If the load is connected across the front panel output terminals, sensing (local or remote) connections must also be made from the front panel. If front panel output connections and rear panel sensing connections are made simultaneously to the load, regulation may deteriorate severely.

2.2.5 Rear Panel Shorting Link Application

The power supply is shipped from the factory with shorting links in place across terminals 1 and 2, 2 and 3, 5 and 6, 6 and 7, of the rear panel barrier strip. In this configuration, and with the load connected across the rear panel output terminals, local sensing and programming operation from the rear panel is provided.

Additional operating configurations may be easily achieved by changing shorting link connections or adding external wiring and controls, as outlined in Table 2-2. However, the output of the power supply will become unregulated, unless the connections listed for at least one of the operating functions is made.

2.2.6 Front Panel Shorting Link Application

Shorting links for the front panel binding post terminals are shipped with the unit, but are not installed. Upon installation of these shorting links, front panel local or remote sensing operating may be selected. However, it must be remembered that if sensing connections to the load are made from the front panel, output connections must also be made from the front panel. Front panel shorting link connections are shows in Table 2-3.

TABLE 2-2 REAR PANEL SHORTING LINK APPLICATION

Selection	Function	Connections Required
1	Local Sensing	1 and 2; 5 and 6
	Local Programming	2 and 3; 6 and 7
2	Local Sensing	1 and 2; 5 and 6
	Remote Programming	PGM resistors across 2 and 3 and/or 6 and 7
3	Remote Sensing	1 and 2 connected at load (–); 5 and 6 connected at load (+)
	Local Programming	2 and 3 and/or 6 and 7
4	Remote	1 and 2 connected at load (–); 5 and 6 connected at load (+)
	Remote Programming	PGM resistors across 2 and 3; 6 and 7

NOTE: If the front panel terminals are to be used and local sensing is desired, place shorting links across the front panel -s, -v and +s, +v binding posts so that the regulation is maintained at the front panel terminals.

TABLE 2-3 FRONT PANEL SHORTING LINK APPLICATION

Terminals	Condition	Function
-S & -V +S & +V	Connected Connected	Local sensing and regulation at front panel output terminals.
-S & -V +S & +V	Not Connected Not Connected	Remote sensing and regulation at load, using four separate and individual leads to load.

2.3 FRONT PANEL CONTROLS

Table 2-4 describes the controls on the front panel of the instrument.

TABLE 2-4 FRONT PANEL CONTROLS

Name	Function
AC Power	Toggle switch, controls input power.
Voltage Adjust (Coarse)	Potentiometer, adjusts voltage output.
Voltage Adjust (Vernier)	Potentiometer, adjusts voltage output.
Current Adjust (Coarse)	Potentiometer, adjusts current.
Current Adjust (Vernier)	Potentiometer, adjusts current.

All internal control settings have been factory preset, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this instruction manual.

2.4 OPERATION

2.4.1 Control Settings

Set all front panel controls fully CW so that unit will operate in the Voltage rather than Current Limiting mode.

2.4.2 Shorting Links

If Local Sensing rather than Remote Sensing operation is desired, ascertain that shorting links are in place across the appropriate terminals.

2.4.3 Grounding

Either side of the Output may be grounded, or the Output may be used in a floating condition.

2.4.5 Power On

Connect the power supply to a nominal AC power source. Set Power Switch S1 to AC - ON, and observe that pilot lamp DS1 glows.

2.4.6 Warm-Up

No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommended to reach rated stability.

2.4.7 Series Operation

To operate two or more power supplies in a series configuration, connect the output of each power supply in series. When operating in this mode, it is necessary to adjust the output of each unit independently. The output voltage is equal to the sum of the voltage setting of each power supply.

2.4.8 Parallel Operation

1) With rated resistive load connected across the output of power supply A as shown in Figure 2-1A, set VOLTAGE ADJUST control to desired output voltage and set CURRENT ADJUST control for maximum rated output current.

2) Connect power supply B as shown in Figure 2-1B. With no load across the output, set VOLTAGE ADJUST control for an output voltage 2V higher than the output voltage of power supply A. Place a short across the output terminals, and set the CURRENT ADJUST control for 1/2 the total load current requirement.

3) Remove all former output loads and connect the outputs of power supplies A and B in parallel with each other, and in parallel with the load, as shown in Figure 2-2.

4) If parallel operation of these two power supplies is desired for a systems application, it is important that both units be turned on simultaneously. It is therefore recommended that both power supplies be connected to a single large circuit breaker. Maximum output current will be twice that of either of the two power supplies, while minimum output current will be that of power supply B, or half the total load current.

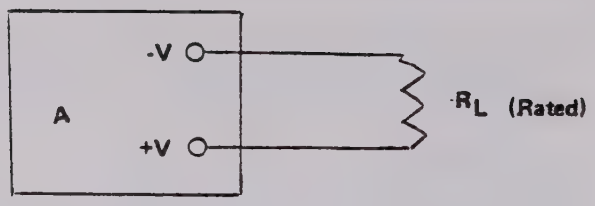


FIGURE 2-1A

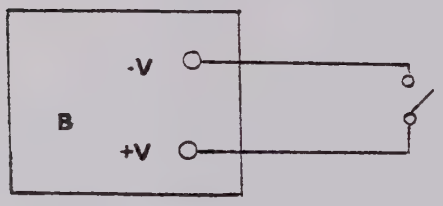


FIGURE 2-1B

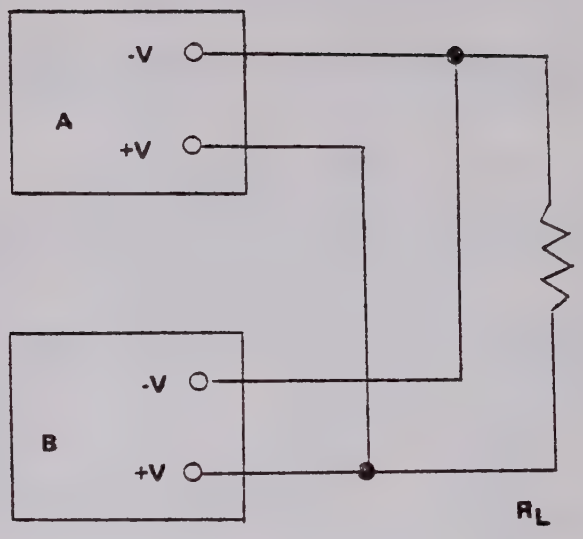


FIGURE 2-2

NOTE: If parallel operation of the power supplies utilizing overvoltage (OV) protection is desired, the above procedure plus the following additional step must be performed:

1. Disconnect the gate lead from the OV SCR in power supply which is set to lower output voltage.

CHAPTER 3

THEORY OF OPERATION

3.1 GENERAL

The purpose of the Medium Power Half Rack Series power supplies is to transform and rectify the AC input into a well-regulated, stable and adjustable DC output. The following paragraphs describe the major circuits used in the power supplies. As each circuit is described, reference should be made to both the Block Diagram, Figure 3-1 and the Schematic Diagram in the rear of this manual.

3.1.1 Primary Input

Input power is obtained through power transformer T1, full wave rectifier diode sets CR1 and CR2, CR3 and CR6, CR4 and CR5, CR7 and CR8, and CR26, CR27 and filter capacitor C1, C16 and C17. Each rectifier set provides the necessary DC voltages to the various sections of the unit.

When AC Power switch S1 is set to AC - ON, AC pilot lamp DS1 glows, and AC power is applied to the power transformer. Regulated DC output power is immediately available from the power supply.

3.1.2 Reference Supply

The rectified and filtered voltage from rectifiers CR1 and CR2 and filter capacitor C1 is preregulated by Coarse Reference Regulator Zener CR12. This provides a stabilized DC voltage to Constant Current Source Q2, whose output is regulated by Precision Voltage Reference Zener CR14. Constant Current Source Q1 controls the drive to Q2 and in turn is control led by Q2. The voltages developed across Constant Current Source References CR13 and CR14 are highly stable reference voltages established at a higher positive potential than the positive output of the supply.

3.1.3 Pre-Regulator

The purpose of the Pre-Regulator section is to maintain the unregulated input voltage on Input Filter Capacitor C16 at a suitable value compared to the output voltage in order to lower the power dissipation across the Series Pass section of the Series Regulator.

The method used to accomplish this is to "fire" a pair of SCR's (silicon controlled rectifiers), CR7 and CR8, at controlled points along the input sine wave to increase or decrease the potential to which the input filter capacitor may charge. The SCR's are "fired" (allowed to pass current) by the application of a positive pulse at the junction of gating resistors R55 and R56, from unijunction transistor Q11. (CR48 and CR49 are used to complete the full wave bridge on HR160-3C.)

The unijunction transistor triggers the SCR's when charged sufficiently by timing capacitor C3 to cause conduction. The timing of the triggering pusle to the SCR's is a function of the voltage across Series Pass transistors and the AC voltage referenced by diode rectifiers CR3 and CR6, and Series Pass Voltage Adjust control R49.

The SCR's are turned off with each alternate half cycle of the input sine wave. Adjustment of R49 is factory set to the optimum full load firing point of the SCR's.

3.1.4 Series Regulator

The pre-regulated DC voltage from the SCR's is directed through the Series Pass transistors. The conduction of these transistors is controlled by circuitry which causes them to act as variable resistors. Their overall resistance varies in accordance wtih the need of the power supply to increase or decrease its output voltage or current.

The Series Pass transistors are controlled by several driver stages which amplify signals from the error amplifier.

3.1.5 Comparator and Error Amplifier

The voltage sensing and comparison is accomplished by differential amplifier Q10. A sample of the output voltage on the base of Q10 is compared to the stable reference voltage on the base of comparator Q9. An unbalance caused by a change in voltage at either the negative sensing terminal or across voltage adjustment controls R25 and R26 will appear as a voltage change in the collector of Q10.

This difference voltage is amplified by error amplifier Q6, and is used to regulate the Series Pass transistors via the Series Pass drivers. Error amplifier Q6 has two diode inputs to its base which form an OR gate for error signals. CR17 supplies error signals from the comparator, and CR16 supplies an error signal in the event of a short circuit, or if the power supply is driven into the current limiting mode of operation.

When operating in the current limiting mode, differential amplifier Q3 and Q4 become balanced, causing diode CR16 to conduct, and in turn, drives error amplifier Q6 toward cut-off. This signal also causes Q7 to conduct, thereby causing current mode indicator lamp DS2 to glow.

3.2 OPTIONAL FEATURES

3.2.1 Overvoltage (OV) Protection

If the output voltage should rise above the programmed output level, a portion of the signal developed across the OV sensitivity control will cause the OV sensor to conduct, which in turn, drives the OV Reference into conduction. The output of the the OV SCR Driver is applied to the gate lead of the OV SCR, causing it to "fire". "Firing" of the OV SCR cuts off the Series Pass drivers and in turn, the Series Pass circuit.

If the overvoltage condition is caused by a short in the Series Pass circuit, the OV SCR will "fire", causing the OV fuse to open.

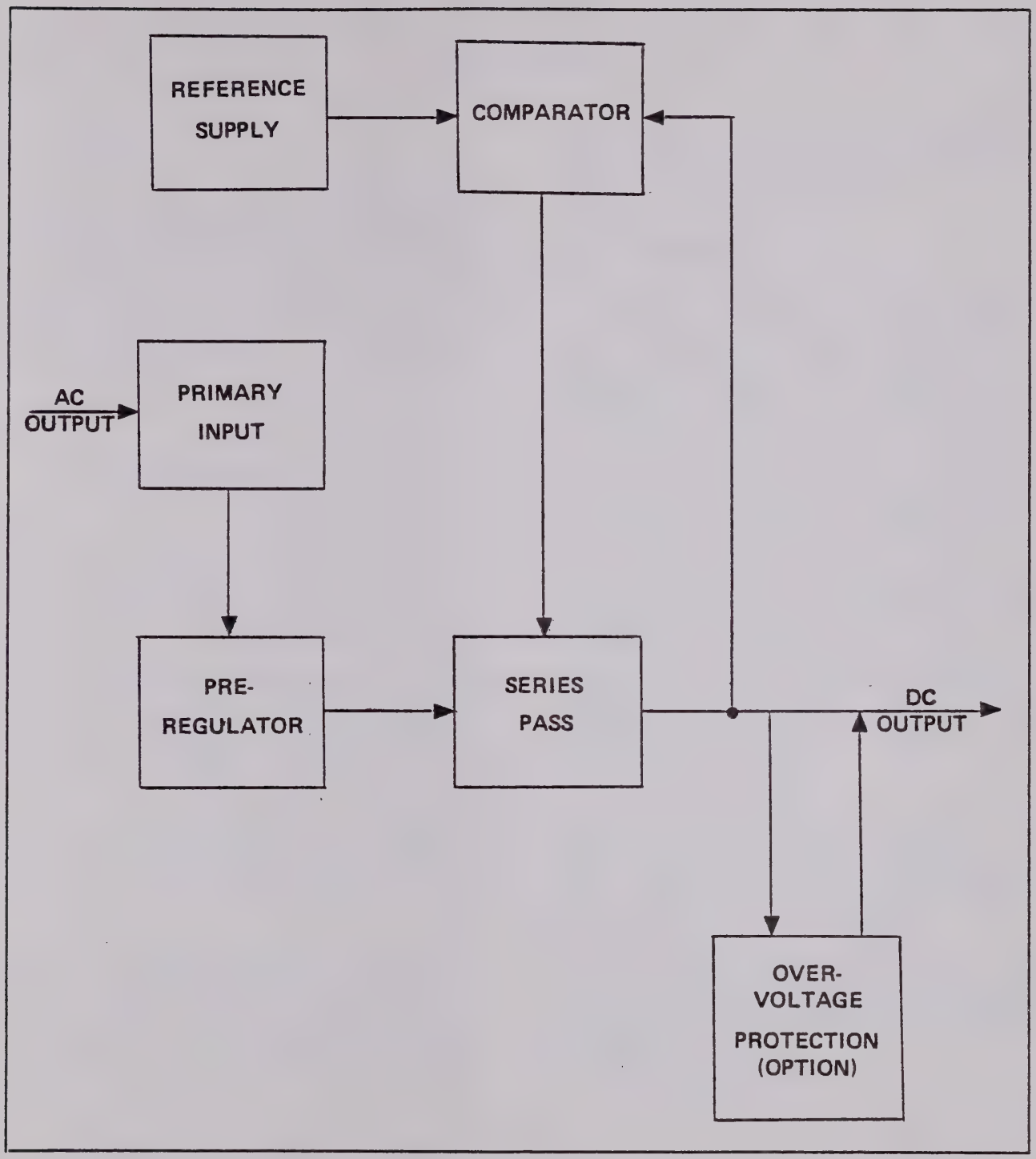


FIGURE 3-1 BLOCK DIAGRAM

CHAPTER 4

MAINTENANCE

4.1 GENERAL

This power supply is a precision instrument. It is strongly recommended that only experienced troubleshooting personnel perform troubleshooting operations or attempt to repair the unit. If the power supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

NOTE

High Voltages are Present, Use Caution.

4.2 LOADS AND INTERCONNECTIONS

1) Disconnect all interconnections and loads to which the unit is normally connected.

2) Place shorting links between rear panel terminals 1 and 2, 2 and 3, 5 and 6, 6 and 7. These connections must be securely made, or deterioration of output regulation will occur.

3) Connect a resistive dummy load across output terminals 1 and 6. This load should be of sufficent value to allow the unit to operate at its maximum rated current and voltage output.

4) Apply nominal AC input power to the unit and check for normal operation. Satisfactory operation at this time would indicate that any malfunction previously encountered, is external in nature. All interconnections and loads normally used in conjunction with this power supply should then be carefully checked for electrical defects.

4.3 TROUBLESHOOTING

1) Set VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CW. Using a 20,000 ohms per volt voltmeter or oscilloscope, check the voltages across the various circuit components listed in the Troubleshooting Guide, located at the end of Chapter 4 in this instruction manual. The sample voltages listed in this guide apply only if the unit is operating at its nominal AC input, and has a dummy load of sufficient size connected across its output to allow operation at maximum rated current and voltage output levels. Any reading which is grossly incorrect indicates that the stage being tested or the one immediately preceding it, is defective. The Block Diagram, Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any troubleshooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2) If voltage checks show no noticeable deviations from the prescribed values, disconnect AC power and proceed with point-to-point resistance checks across potentiometers, switches, diodes, resistors and transistors, in that order.

3) When the trouble is of an intermittent nature such as poor regulation, ripple, etc., the use of an oscilloscope to determine dynamic ahnges will be necessary.

TROUBLE SHOOTING GUIDE - HR20, HR40 and HR60 C SERIES

SECTION	COMPONENT	FUNCTION	DC VOLTS ±10%
REFERENCE	CR12	Coarse Reference Regulator	24.0
	CR13	Constant Current Source Reg.	5.1
	CR14	Precision Voltage Reference	9.5
	CR22	Current Differential Offset Reference	5.1
PRE-REGULATOR	C16	Input Filter Capacitor	9.5 volts greater than output.
SERIES REGULATOR	C17	Output Bleed Filter	36.0
	Q16,17,20	Series Pass	8.5
	Q21	Series Pass Driver	17.0
	R41	Biasing Resistor	6.5
	R72	Output Bleed Resistor	56.0 - HR20 76.0 - HR40 96.0 - HR60
COMPARATOR & ERROR AMP.	Q6	Error Amplifer	2.5
	Q9,10	Output Comp. & Amplifier Measure between Q9,Q10 and + Sense	4.0
	R16,17	Reference Divider Network	9.5
	R21	Common Mode Resistor	2.7

NOTES

Base to emitter voltages of all transistors in the Series Regulator, should be positive for conduction.

Series Pass voltage is measured from the collector of Q15 to the emitter of Q16.

Series Pass Driver voltage is measured between the collector and emitter of Q21.

CHAPTER 5

CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the power supply;

5.2 TEST EQUIPMENT REQUIRED (Or Equivalent)

1) Oscilloscope, Tektronix Type 561
2) Differential Amplifier Plug-In, Tektonrix Type 63.
3) Time Base Plug-In, Tektronix Type 67.
4) Multimeter, Systron Donner Model 9025
5) Variable Auto Transformer, Powerstat Type 3PN136 (20 ampere rating).

5.2.1 Shorting Link Application

For test purposes, shorting links should be connected across terminals 1 and 2, 2 and 3, 5 and 6, 6 and 7, to provide local sensing and local voltage programming. To reduce pick up, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground loops, it is important that only one ground connection be made, as shown in Figure 5-1 and Figure 5-2. Tighten all terminal connections as securely as possible, and set all front panel controls fully CW.

5.3 CALIBRATION PROCEDURE

5.3.1 Pre-Regulator

1) With power supply operating without a resistive load across the output terminals, vary VOLTAGE ADJUST control until 100% of rated voltage output is indicated on the DC voltmeter. Set AC POWER switch S1 to OFF, and connect resistive load across the output terminals. Set AC POWER switch S1 back to ON, and adjust resistive load for rated current setting on Ammeter.

2) Set oscilloscope to DC triggering mode and connect scope input across the positive terminals of input capacitor C16 and output capacitor C9.

3) Adjust Pre-Regulator Input Balance control R53 for a balanced 120 cps sawtooth shaped waveform.

4) Adjust Series Pass Voltage control R49 for approximately 10 Vdc, measured between the positive terminals of input capacitor C16 and output capacitor C9.

5) Vary AC input power 10% above and below the nominal input level. Observe that the voltage measured between the positive terminals of the input and output capacitors, does not vary by more than 1.5 Vdc, at either input voltage extreme.

5.3.2 Voltage Adjust Control

1) Maximum Voltage: Set front panel VOLTAGE and VOLTAGE VERNIER controls fully CW. Adjust Maximum Voltage control R86 to obtain an output voltage 0.5 Vdc in excess of the maximum rated output voltage.

2) Minimum Voltage: Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CCW. Adjust Minimum Voltage control R87 to obtain a negative output voltage of 0.1 Vdc.

3) Readjustment: Adjustment of either Maximum Voltage control R86 or Minimum Voltage control R87 will have an effect upon the other. Therefore, these controls should be readjusted if necessary, as outlined in above paragraphs 1) and 2), upon initial completion of this adjustment.

NOTE: If partial rotation of the VOLTAGE ADJUST controls produces no apparent change in indicated output voltage, further rotation of these controls should not be attempted. Rotation

of these controls fully CCW with little or not output voltage regulation can result in damage to the controls, the load, or both. Set the AC POWER switch to OFF, and proceed with the troubleshooting outlined in Chapter 4.

Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CCW and observe that the voltage indicated on the unit and test voltmeters drops slightly below the zero setting of the meters. The output voltage should be slightly negative. Reset voltage controls fully CW.

5.3.3 Current Adjust Controls

1) Maximum Current: Connect a test ammeter having a full scale current indicating capacity of 150% that of the rated current output across the output terminals of the power supply. (Set all front panel controls fully CCW.) Apply power to the unit under test and slowly rotate CURRENT controls fully CW. Observe that the maximum current obtainable is approximately 105% that of the maximum rated current output. If it is not possible to achieve 105% of the maximum rated current output, adjust Maximum Current control R37 until that value is attained. Set AC POWER switch to OFF. Connect a suitable load resistance across the output terminal connections. The load resistance must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Set AC POWER switch to ON. Note the voltage indicated on the DVM. Disconnect the resistive load from the output and observe the voltage indicated on the DVM. The maximum change in output voltage should not exceed by more than 0.01% or 3 mV (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

If it is not possible to maintain the load regulation as stated in the preceding paragraph, readjust Maximum Current control R37 slightly and recheck the load regulation.

2) Minimum Current: Connect test ammeter, having a full scale current indicating capacity of 100 mA, across output terminals in place of a load resistor. Set all front panel controls fully CCW and apply power to the unit under test. Slowly rotate VOLTAGE ADJUST control in a CW direction, until current meter indicates a current flow somewhere between 0-50 mA. Adjust Minimum Current control R29 for a nominal current indication of 1% of the rated current. Set POWER ON switch S1 to OFF.

5.3.4 Constant Voltage Operation

1) Load Regulation: With the equipment connected as shown in Figure 5-1, connect a suitable load resistance across the Output terminals connections. The load resistance selected must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the DVM. Disconnect the resistive load from the output. The maximum change in output DC voltage indicated on the DVM should not exceed by more than 0.01% or 3 mV (whichever is greater) that of the output voltage indicated with the load resistance applied across the terminals.

2) Line Regulation: Place the resistive load across the output and note the voltage indicated on the DVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum change in output voltage should not exceed by more than 0.01% or 2 mV (whichever is greater) that of the output voltage measured at either extreme of the AC input.

3) Ripple Voltage: In order to reduce pickup, shielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the AC DVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum ripple amplitude should not exceed 0.5 mV RMS.

5.3.5 Constant Current Operation

1) Load Regulation: With the equipment turned off, disconnect the resistive load from the output terminals. Connect a small current sensing resistor in series with the resistive load and then connect the load back across the output terminals.

Selection of the proper value for the current sensing resistor may be easily made suing the formula $R_S = I/I_R$ where R_S = Value of Current Sensing Resistor and I_R = Rated Load Current. Connect the equipment as shown in Figure 5-2, and apply power to the power supply.

Vary the VOLTAGE ADJUST controls and resistive output load as necessary, to achieve rated current and voltage output. Decrease the load resistance until current meter reading exceeds full scale indication. Rotate CURRENT ADJUST control CCW to return the current meter reading to full scale. Observe that the output voltage has decreased from its previous full scale reading, and that increasing the VOLTAGE ADJUST controls has no effect upon the output voltage or current. This indicates that the unit is now operating in the Constant Current Mode.

Measure the voltage across the small sensing resistor. Compute and note the current flow through this resistor. Change the output load from the resistive load previously used, to a short. Again measure the voltage across the small sensing resistor and compute the value of the current flow through this resistor. The change in current should not exceed by more than 0.5% the rated current previously noted with a full resistive load across the output.

2) Line Regulation: Replace the resistive load across the output and measure the voltage drop across the small sensing resistor. Compute and note the current flow ($I = \frac{E}{R}$) through this resistor. Vary the input line voltage between 105 and 125 Vac. Note the maximum change in voltage across the sensing resistor and compute the maximum current flow. The maximum change in current should not exceed by more than 0.5% the rated current previously noted at either extreme of the AC input.

3) Ripple Current: With the AC input line voltage adjusted to the moninal value of 115V and the resistive load connected across the output, measure the amplitude of the AC ripple as seen across the sensing resistor with the AC DVM. Compute and note the current flow. Vary the AC input line voltage between 105 and 125 Vac. Measure the maximum voltage drop and compute the maximum current flow. The maximum ripple current must not exceed by more than 0.25% or 5 mA (whichever is greater) that of the current flow noted during nominal input line voltage.

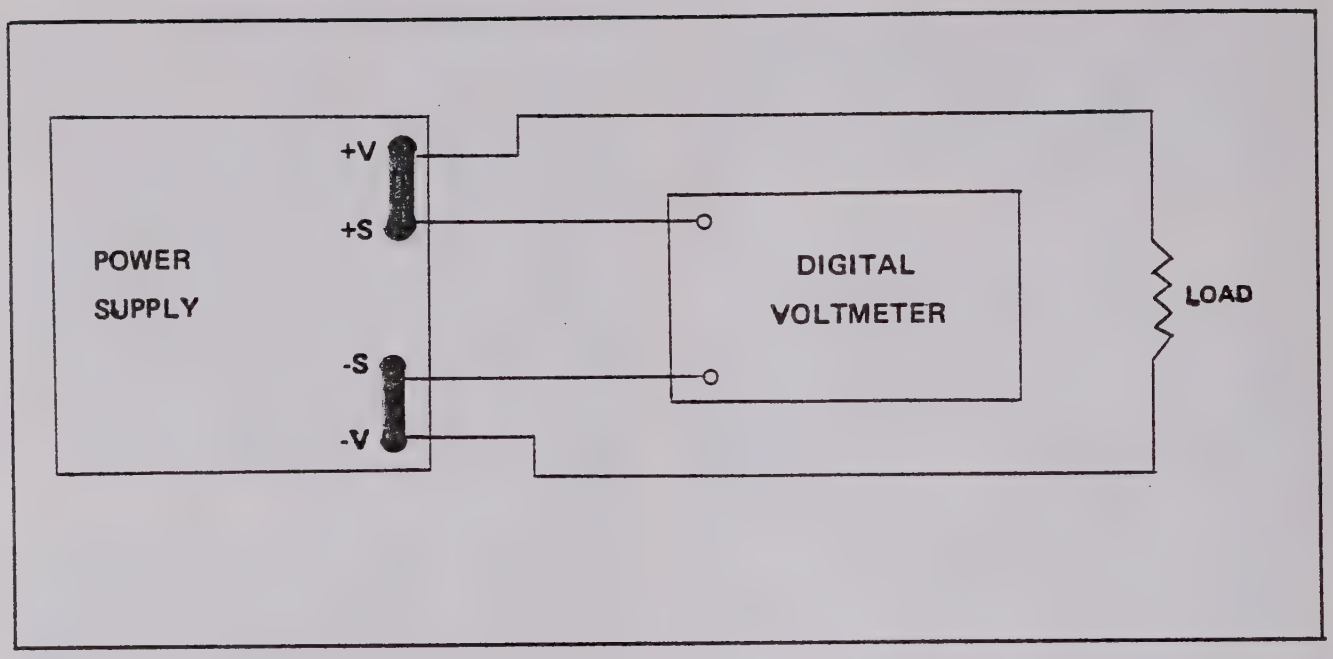


FIGURE 5-1 CONSTANT VOLTAGE OPERATION

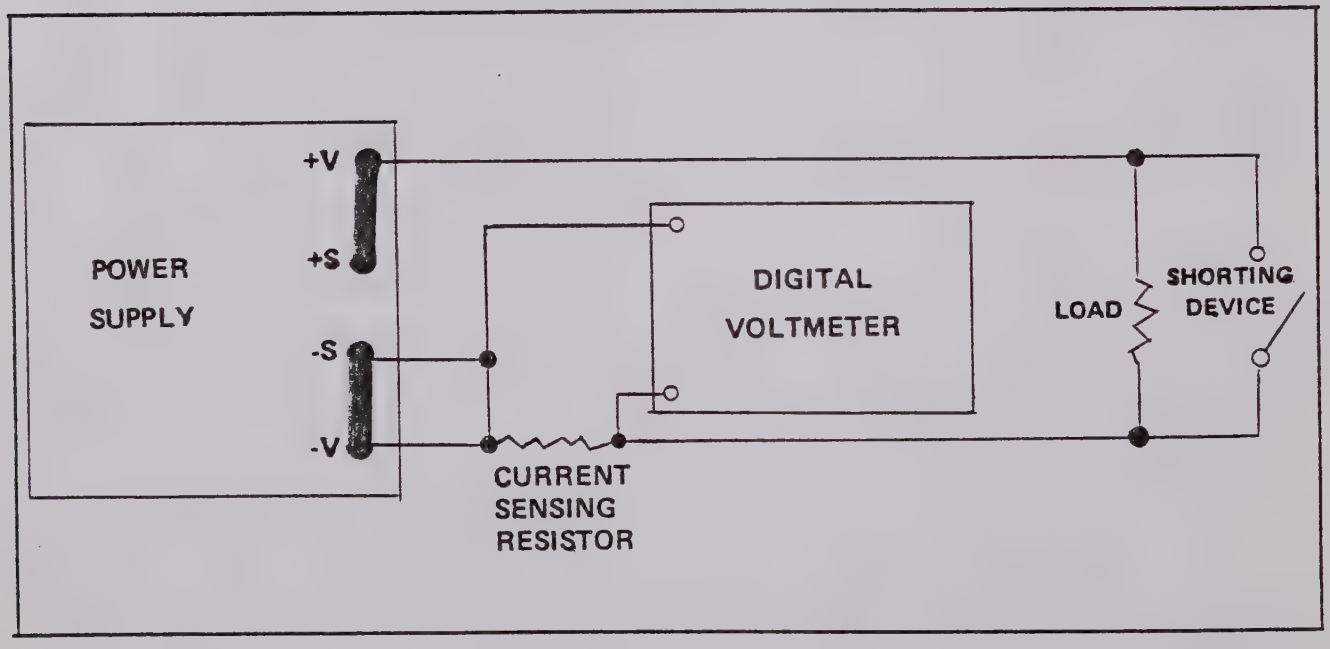


FIGURE 5-2 CONSTANT CURRENT OPERATION

CHAPTER 6

PARTS LIST

6.1 INTRODUCTION

This chapter contains the parts list for each assembly in the HRC Series Power Supplies. Chapter 7 shows the assemblies where the listed parts are installed. Ordering information is included and should be used when purchasing parts from the factory. Explanation of the column listings and Table 6-1 Manufacturer's Code-To-Name Index are also included.

6.2 PART ORDERING INFORMATION

To order a part from the Replaceable Parts List, state the Systron-Donner part number, and indicate the quantity required and address the order to the nearest Systron Donner Sales or Service Center.

To order a part not listed in the Replaceable Parts List, state the instrument model number, instrument serieal number, the description and function of the part and the number of parts required. Address the order to the nearest Systron Donner Sales or Service Center.

6.3 PARTS LIST

Each column in the parts lists provide specific information relating to the listed parts.

TABLE 6-1 MANUFACTURER'S CODE-TO-NAME INDEX

Code	Name & Address
01121	Allen-Bradley Co. 1201 So. 2nd Street Milwaukee, WI 53204
02735	RCA Corp. Solid State Division Route 202 Somerville, NJ 08876
03877	Transitron Electronic Corp. 168 - 186 Albion Street Wakefield, MA 01880
04713	Motorola Semiconductor Prod. Inc. 5005 E. McDowell Road Phoenix, AZ 85008
06776	Robinson Nugent Inc. P.O. Box 470 New Albany, IN 47105
08289	The Delbert Blinn Co. Inc. P.O. Box 2007 1678 Mission Blvd. Pomona, CA 91766
11236	CTS of Berne Inc. 406 Parr Road Berne, IN 46711
15915	Tepro of Florida Inc. 2608 Enterprise Road Dunedin, FL 33528
16758	Delco Radio Division of General Motors Corp. Kokomo, IN
17117	Electronic Molding Corp. 96 Mill Street Woonsocket, RI 02895
19701	Mepco/Electra Inc. Electra Division P.O. Box 760 Mineral Wells, TX 76067
52542	Systron Donner Corp. Instrument Division 2727 Systron Drive Concord, CA 94518
52736	Stettner-Trush Inc. 67 Albany Street Cazenovia, NY
56289	Sprague Electronic Co. North Adams, MA 01247
58474	Superior Electric Co. 383 Middle Street Bristol, CT 06010
70903	Belden Corp. 415 So. Kilpatrick Chicago, IL 60644
71590	Globe-Union Inc. Centralab Electronics Division 5757 No. Green Bay Avenue Milwaukee, WI 53201
75042	TRW Electronic Components Fixed Resistors Philadelphia Div. 401 N. Broad Street Philadelphia, PA 19108
75382	Kulka Electric Corp. 633 - 643 S. Fulton Avenue Mt. Vernon, NY 10550
75915	Littlefuse Inc. 800 E. Northwest Hwy. Des Plaines, IL 60016
81349	MIL STD
82389	Switchcraft Inc. 5555 N. Elston Avenue Chicago, IL 60630
90201	Mallory Capacitor Co. P.O. Box 372 3029 E. Washington Street Indianapolis, IN 46206
91637	Dale Electronics Inc. P.O. Box 609 Columbus, NB 68601
91802	Industrial Devices Inc. 982 River Rd. Edgewater, NJ 07020
96733	San Fernando Electric Mfg. Co. 1509 First Street San Fernando, CA 91341
99392	S T M Corp. 2904 Chapman Street Oakland, CA 94601

TITLE HRC SERIES SHIPPING ASSEMBLY

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Shipping	52542	T63200	T63200	1
		2	ASSEMBLY, Shipping	52542	T63400	T63400	1
		3	ASSEMBLY, Shipping	52542	T63600	T63600	1
		4	ASSEMBLY, Shipping	52542	T63700	T63700	1
		1-4	LINKS, Shorting	52542	T012240	T012240	2
		1-4	LINKS, Shorting	52542	100561	100561	1
			COVER ASSEMBLY				
		1-4	ASSEMBLY, Cover	52542	057184	057184	1
		1-4	HANDLE	52542	T920050	T920050	1
		1-4	RIVETS	52542	T960290	T960290	6
			CHASSIS ASSEMBLY				
		1	ASSEMBLY, Chassis	52542	PD25876	PD25876	1
		2	ASSEMBLY, Chassis	52542	PD25882	PD25882	1
		3	ASSEMBLY, Chassis	52542	PD25871	PD25871	1
		4	ASSEMBLY, Chassis	52542	PD25807	PD25807	1
	C1	1-4	CAPACITOR, El Can 500 µF,75V	52542	820010	820010	1
	C9	1	CAPACITOR, El Can 37500 µF,35V	52542	820334	820334	1
	C9	2,3	CAPACITOR, El Can 6200 µF,75V	52542	820279	820279	1
	C9	4	CAPACITOR, El Can 2000 µF,170V	52542	820136	820136	1
	C16	1	CAPACITOR, El Can 37500 µF,35V	52542	820393	820393	1
	C16	2	CAPACITOR, El Can 2000 µF,60V	52542	820369	820369	1
	C16	3	CAPACITOR, El Can 20000 µF,75V	52542	820367	820367	1
	C16	4	CAPACITOR, El Can 4000 µF,180V	52542	820203	820203	1
	C26	4	CAPACITOR, Cer 1000 pF 1 kV	91418	10007601	10007601	1
	C27	4	CAPACITOR, El Can .01 µF,600V	52542	800090	800090	1
	C28	4	CAPACITOR, El Can .047 µF,400V	52542	800155	800155	1
	C33	1-3	CAPACITOR, El Can .1 µF,250V	52542	800185	800185	1
	R33	1,2	RESISTOR, WW .1 Ω, 25W			650040	1
	R33	3	RESISTOR, WW .14 Ω, 25W			650052	1
	R33	4	RESISTOR, WW 5 k, 25W			650802	1
	R75	1	RESISTOR, WW 350 Ω, 5W			640431	1
	R75	2	RESISTOR, WW 700 Ω, 5W			640493	1
	R75	3	RESISTOR, WW 1.5 k, 5W			640525	1
	R75	4	RESISTOR, WW 5 k, 25W			650802	1
	T1	1	TRANSFORMER	52542	500134	500134	1
	T1	2	TRANSFORMER	52542	500173	500173	1
	T1	3	TRANSFORMER	52542	500193	500193	1
	T1	4	TRANSFORMER	52542	500197	500197	1
		1	SPACER	52542	860297	860297	5
		1-4	BRACKET, Cap 3"	52542	T900065	T900065	1
		1-4	BRACKET, Cap 2"	52542	T900068	T900068	1
		1-4	BRACKET, Cap 1-3/8"	56289	CM5-22	100725	1
		1-4	STANDOFF, 6	17117	3023-14-1	860070	1
		1-4	BUSHING, Shoulder	52542	T046120	T046120	9

Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

TITLE HRC SERIES SHIPPING ASSEMBLY (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-4	CLAMP, Cable	52542	T930080	T930080	2
		1-4	CLAMP, Cable	52542	T930090	T930090	1
		1-4	CLAMP, Cable	52542	T930100	T930100	1
		1-4	WASHER, Shoulder	52542	T046120	T046120	9
		1-4	WASHER, Cup	52542	T990000	T990000	2
		1-4	FEET, Rubber	52542	840192	840192	4
			DIODE ASSEMBLY				
		1-4	ASSEMBLY, Diode	52542	057057	057057	1
		1-4	BRACKET, Diode	52542	078198	078198	1
	CR12	1-4	DIODE, Zener 24V	04713	1N1360A	720241	1
		1-4	KIT, Diode Mtg.	52542	T990350	T990350	1
			FRONT PANEL ASSEMBLY				
		1	ASSEMBLY, Front Panel	52542	PD25333	PD25333	1
		2	ASSEMBLY, Front Panel	52542	PD25157	PD25157	1
		3	ASSEMBLY, Front Panel	52542	PD25274	PD25274	1
		4	ASSEMBLY, Front Panel	52542	PD25406	PD25406	1
		1-4	BOARD	52542	065049	065049	1
	M1	1	ASSEMBLY, Meter 40V	52542	06517102	06517102	1
	M1	2	ASSEMBLY, Meter 20V	52542	06517002	06517002	1
	M1	3	ASSEMBLY, Meter 60V	52542	06517202	06517202	1
	M1	4	ASSEMBLY, Meter 160V	52542	06517301	06517301	1
	M2	1	ASSEMBLY, Meter 10A	52542	06516301	06516301	1
	M2	2	ASSEMBLY, Meter 15A	52542	06516401	06516401	1
	M2	3	ASSEMBLY, Meter 8A	52542	06516201	06516201	1
	M2	4	ASSEMBLY, Meter 3A	52542	06516101	06516101	1
	R25,26	1	RESISTOR, Var. Dual 4 Ω-100 Ω	52542	605030	605030	1
	R25,26	2	RESISTOR, Var.Dual 2 k-100 Ω	52542	605020	605020	1
	R25,26	3	RESISTOR, Var.Dual 6 k-100 Ω	52542	605040	605040	1
	R25,26	4	RESISTOR, Var.Dual 16 k-100 Ω	52542	605100	605100	1
	R31,84	1-4	RESISTOR, Var.Dual 250 Ω-25 Ω	52542	605010	605010	1
	R98	4	RESISTOR, WW 1 k 5W	52542	640510	640510	1
		1	LABEL	52542	781677	781677	1
		2	LABEL	52542	781679	781679	1
		3	LABEL	52542	781681	781681	1
		4	LABEL	52542	781682	781682	1
		1-4	LIGHT, Pilot	91802	1040D32	770020	1
		1-4	LIGHT, Indicator	91802	2190A87	770023	1
		1-4	STRIP, Terminal	52542	859020	859020	1
		1-4	SWITCH, DPST	52542	880030	880030	1
		1-4	KNOB, Gray	52542	T920110	T920110	2
		1-4	KNOB, Black	52542	T920111	T920111	2

Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

TITLE			HRC SERIES SHIPPING ASSEMBLY (Cont'd)				
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-4	BINDING POST, Black	58474	DF21BC	102647	2
		1-4	BINDING POST, Red	58474	DF21RC	T920160	2
		1-4	BINDING POST, White	58474	DF21WTC	102648	1
		1-4	NUT, Ring	52542	T980120	T980120	1
			REAR PANEL ASSEMBLY				
		1	ASSEMBLY, Rear Panel	52542	PD25259	PD25259	1
		2	ASSEMBLY, Rear Panel	52542	PD25883	PD25883	1
		3	ASSEMBLY, Rear Panel	52542	PD25872	PD25872	1
		4	ASSEMBLY, Rear Panel	52542	PD25808	PD25808	1
		1-4	BOARD	52542	119214	119214	1
	C23	1	CAPACITOR, Tant 6.8 μF, 35V	56289	150D685X9035B	100182	1
	C23	2	CAPACITOR, Tant 2 μF, 50V	52542	810006	810006	1
	C23	4	CAPACITOR, Tant 1 μF, 250V	52542	810002	810002	1
	F1	1-3	FUSE, 10A	52542	870201	870201	1
	F1	4	FUSE, 15A	52542	870212	870212	1
	F2	1	FUSE, 20A 32V	52542	870110	870110	1
	F2	2	FUSE, 15A 250V	52542	870212	870212	1
	F2	3	FUSE, Slo-Blo 12A	52542	870202	870202	1
	F2	4	FUSE, 5A 250V	52542	870069	870069	1
	R72	1	RESISTOR, WW 1.5 k 10W	75042	BWH	640527	1
	R72	2	RESISTOR, WW 3 k, 10W	75042	BWH	640542	1
	R72	3	RESISTOR, WW 4 k, 10W	75042	BWH	640541	1
		1-4	STRIP, Barrier	52542	851611	851611	1
		1-4	PLATE, Insulator	52542	859040	859040	1
		1-4	LINE CORD	70903	17502	117680	1
		1-4	RECEPTICLE, AC Input	82389	EAC-301	101288	1
		1-3	LABEL, Fuse 10A	52542	780530	780530	1
		4	LABEL, Fuse 10	52542	780680	780680	1
		1-4	NAME PLATE	52542	T101040	T101040	1
		1-4	LINK, Barrier Strip	75382	600J	840217	4
		1-4	HOLDER, Fuse	75915	345001	117377	1
		1-4	BLOCK, Fuse	75915	357001	102440	1
			HEATSINK ASSEMBLY #1				
		1	ASSEMBLY, Heatsink	52542	PD25160	PD25160	1
		2	ASSEMBLY, Heatsink	52542	PD25336	PD25336	1
		3	ASSEMBLY, Heatsink	52542	PD25277	PD25277	1
		4	ASSEMBLY, Heatsink	52542	PD25409	PD25409	1
		1-3	BOARD	52542	039110	039110	1
		4	BOARD	52542	T063240	T063240	1
	CR35	2,3	DIODE, Rectifier 400V	04713	1N5395	100413	1
	CR35,38, 52	4	DIODE, Rectifier 400V	04713	1N5395	100413	3

Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HRC160-3COV

TITLE HRC SERIES SHIPPING ASSEMBLY (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	Q16,17	1,2	TRANSISTOR, SINPN Selected	52542	705071	705071	2
	Q16,17	3	TRANSISTOR, SINPN	02735	2N3442	700085	2
	Q16	4	TRANSISTOR, SINPN	02735	DTS-411	700429	1
	Q17	4	TRANSISTOR, SINPN	02735	2N3548	700420	1
	R64,65	1,2	RESISTOR, WW .1 Ω 10%, 3W	15915	TS2C	640010	2
	R64,65	3	RESISTOR, WW .1 Ω 10%, 3W	15915	TS2D	640020	2
	R65	4	RESISTOR, CC 1 k 5%, 1/2W	01121	EB1025	101467	1
	R67	4	RESISTOR, WW .2 Ω 10%, 3W	15915	TS2D	640020	1
	R96	2	RESISTOR, WW 2 k 3%, 3W	15915	TS2C	630440	1
	R96	3,4	RESISTOR, WW 5 k 3%, 3W	15915	TS2C	630490	1
	R97	2	RESISTOR, WW 330 Ω 3%, 3W	15915	TS2C	630290	1
	R97	3	RESISTOR, WW 700 Ω 3%, 3W	15915	TS2C	630370	1
	R97	4	RESISTOR, WW 625 Ω 3%, 3W	15915	TS2C	630360	1
	R108	4	RESISTOR, CC 2.2 k 5%, 1/2W	01121	EB2225	101454	1
		4	SOCKET, Transistor			830075	1
		1-4	SOCKET, Transistor	06776	MD-3452-G	830070	2
		1-4	STANDOFF, 4-40	17117	2304-14-1	860020	4
		1-4	WASHER, Mica	08289	DM-111	103358	2
		4	STRIP, Terminal	52542	859019	859019	1
			HEATSINK ASSEMBLY #2				
		1	ASSEMBLY, Heatsink	52542	PD25878	PD25878	1
		2	ASSEMBLY, Heatsink	52542	PD25884	PD25884	1
		3	ASSEMBLY, Heatsink	52542	PD25873	PD25873	1
		4	ASSEMBLY, Heatsink	52542	PD25809	PD25809	1
	CR45	1-3	DIODE, Rectifier 50V	04713	1N3615	720129	1
	CR45	4	DIODE, Rectifier 100V	04713	MR1121	720132	1
	CR46	1	DIODE, SCR	04713	MCR649AP-2	720280	1
	CR46	2,3	DIODE, SCR	04713	MCR649AP-3	720290	1
	CR46	4	DIODE, SCR	04713	MCR649AP-4	720300	1
	L3	3	CHOKE	52542	503009	503009	1
	Q14	1-3	TRANSISTOR, SINPN	02735	2N4915	700191	1
	Q15	4	TRANSISTOR, SINPN	16758	DTS-411	700429	1
	Q20	1,2	TRANSISTOR, SINPN Selected	52542	705071	705071	1
	Q20	3	TRANSISTOR, SINPN	02735	2N3442	700085	1
	R66	4	RESISTOR, WW .2 Ω 10%, 3W	15915	TS2D	640020	1
	R85	1,2	RESISTOR, WW .1 Ω 10%, 3W	15915	TS2C	640010	1
	R85	3	RESISTOR, WW .2 Ω 10%, 3W	15915	TS2D	640020	1
		1-4	SOCKET, Transistor Large	52542	830070	830070	2
		1-4	SOCKET, Transistor Small	04713	MK-25	100937	1
		1-4	WASHER, Mica	08289	DM-111	103358	2
		1-3	WASHER, Mica	08289	TA-2402-A	100551	1
		1-4	STANDOFF, 4-40	17117	2304-14-1	860020	2

Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

TITLE: HRC SERIES SHIPPING ASSEMBLY (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-4	WASHER, Flat	52542	T990306	T990306	1
		1-4	WASHER, Mica	52542	T990307	T990307	2
		1-4	RING, Insulator	52542	T990350	T990350	1
		1-4	LUG, Solder	52542	116969	116969	1
			HEATSINK ASSEMBLY #3				
		1	ASSEMBLY, Heatsink	52542	PD25162	PD25162	1
		2	ASSEMBLY, Heatsink	52542	PD25338	PD25338	1
		3	ASSEMBLY, Heatsink	52542	PD25279	PD25279	1
		4	ASSEMBLY, Heatsink	52542	PD25412	PD15412	1
		1-4	BOARD	52542	T063210	T063210	1
	C19,25	1-3	CAPACITOR, .01 μF, 600V			800090	2
	CR7,8	1	DIODE, SCR 100V	04713	MCR649AP-3	720290	2
	CR7,8	2,3	DIODE, SCR 200V	04713	MCR649AP-4	720300	2
	CR7,8	4	DIODE, SCR 300V	04713	MCR649AP-5	720301	2
	CR48,49	4	DIODE, Rectifier 300V	04713	1N1203A	720133	2
	CR50,51	4	DIODE, Rectifier 400V	04713	1N5395	100413	2
	L1,2	1	CHOKE	52542	503017	503017	1
	L1,2	2	CHOKE	52542	503023	503023	1
	L1,2	3	CHOKE	52542	503030	503030	1
	L1,2	4	CHOKE	52542	503035	503035	1
	R98,99	1,2	RESISTOR, CC 100 Ω 5%, 1/2W	01121	EB1015	101498	2
	R98,99	3	RESISTOR, CC 150 Ω 5%, 1/2W	01121	EB1515	101527	2
		1-4	BOARD, Choke	52542	062918	062918	1
		1-4	WASHER, Mica	52542	T018330	T018330	2
		1-4	WASHER, Mica	08289	DM-111	103358	2
		1-4	INSULATOR	52542	T049338	T049338	2
		1-4	SOCKET, Transistor	52542	830070	830070	2
		1-4	STANDOFF, 4-40	17117	2304-14-1	860020	4
			PC BOARD ASSEMBLY				
		1	ASSEMBLY, PC Board	52542	PD25153	PD25153	1
		2	ASSEMBLY, PC Board	52542	PD25329	PD25329	1
		3	ASSEMBLY, PC Board	52542	PD25270	PD25270	1
		4	ASSEMBLY, PC Board	52542	PD25402	PD25402	1
		1-4	BOARD, PC	52542	065558	065558	1
	C2	1-3	CAPACITOR, MF .15 μF, 250V	52763	MKT1813-415/25	800210	1
	C2	4	CAPACITOR, MF .22 μF, 250V			800252	1
	C3,20	1-4	CAPACITOR, MF .1 μF, 250V	52763	MKT1813-410/25	800185	2
	C4	1-4	CAPACITOR, Tant 68 μF, 50V	06001	76F02LN680	810080	1
	C5	1-4	CAPACITOR, MF .047 μF, 250V	52763	MKT1813-447/25	800147	1
	C6	1-3	CAPACITOR, Cer. .0033 μF,600V	71590	CE-332	800025	1
	C6	4	CAPACITOR, Cer .01 μF, 600V	71590	DD6-103	800090	2
	C7	1-3	CAPACITOR, Cer .01 μF, 600V	71590	DD6-103	800090	1
	C7	4	Same as C6				

Used On Code: HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

TITLE: HRC SERIES SHIPPING ASSEMBLY (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	C11	1-4	CAPACITOR, MF .22 µF, 250V	52763	MKT1813-422/25	800252	1
	C17	1,3,4	CAPACITOR, MF 18 µF, 150V	52736	MKT1813-418/15	810030	1
	C17	2	CAPACITOR, Tant 45 µF, 175V	90201	TCW	810065	1
	C21	1-3	CAPACITOR, Cer .001 µF, 600V	91418	TYPE B	100076	1
	C22	1,2	CAPACITOR, El Ax 10 µF, 50V	56289	TE1304	106445	1
	C22	4	CAPACITOR, El Ax 2.2 µF, 250V			800325	1
	C29,30	1-4	CAPACITOR, Tant 68 µF, 6V	56289	196D86X0006KA1	821019	2
	C31	4	CAPACITOR, Cer .0047 µF, 600V	71590	DD-472	800050	1
	CR1-6,15-18,26-29,31,34	1-4	DIODE, Rectifier 400V	04713	1N5395	100413	17
	CR10	1-4	DIODE, Zener 7.5V	04713	1N755A	102992	1
	CR11,13 22	1-4	DIODE, Zener 6.1V	03877	1N751A	100378	3
	CR14	1-4	DIODE, Reference 9.4V	04713	1N2163A	720262	1
	CR33	1-4	DIODE, Rectifier 200V	04713	G2D-E016	720060	1
	CR36	4	DIODE, Zener 20V	04713	1N968B	100409	1
	Q1,3-5,7-10,12,21	1-4	TRANSISTOR, SINPN	04713	2N2714	700180	10
	Q2,6,18	1-4	TRANSISTOR, SIPNP	04713	2N2905A	705067	3
	Q11	1-4	TRANSISTOR, Selected	52542	720145	720145	1
	Q13	1-4	TRANSISTOR, SINPN	02735	2N3440	101420	1
	R1	1-4	RESISTOR, WW 200 Ω 3%, 3W	15915	TS2D	640389	1
	R2	1-4	RESISTOR, MF 10 k 1%, 1/4W	81349	RN65D1001F	620608	1
	R3	1-4	RESISTOR, CC 47 k 10%, 1/2W	01121	EB2725	101437	1
	R4	1-4	RESISTOR, MF 1.18 k 1%, 1/2W	81349	RN65D1181F	620320	1
	R5	1-4	RESISTOR, MF 150 Ω 1%, 1/2W	81349	RN65D1500F	102062	1
	R6	1-4	RESISTOR, MF 1.96 k 1%, 1/2W	81349	RN65D1961F	620402	7
	R7	1-4	Same as R6				
	R8	1-3	RESISTOR, CC 100 Ω 10%, 1/2W	01121	EB1015	101498	3
	R8	4	RESISTOR, CC 100 Ω 10%, 1/2W	01121	EB1015	101498	2
	R9	1-4	RESISTOR, MF 750 Ω 1%, 1/2W	81349	RN65D7500F	620250	3
	R10	1-3	RESISTOR, CC 470 Ω 5%, 1/2W	01121	EB4715	101539	3
	R10	4	RESISTOR, CC 470 Ω 5%, 1/2W	01121	EB4715	101539	2
	R11	1-4	Same as R6				
	R12	1-3	RESISTOR, CC 220 Ω 5%, 1/2W	01121	EB2215	1016167	1
	R12,20	4	RESISTOR, CC 220 Ω 5%, 1/2W	01121	EB2215	101667	2
	R13	1-4	RESISTOR, CC 560 Ω 5%, 1/2W	01121	EB5615	101631	1
	R14	1-4	RESISTOR, CC 100 k 5%, 1/2W	01121	EB1045	101480	1
	R15	1-4	RESISTOR, MF 402 Ω 1%, 1/2W	81349	RN65D4020F	620140	1
	R16	1-4	Same as R9				
	R17	1-4	RESISTOR, MF 1.5 k 1%, 1/2W	81349	RN65D1501F	620360	1
	R18	1-4	Same as R6				
	R19	1-4	Same as R6				
	R20	1-3	Same as R8				

Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

TITLE: HRC SERIES SHIPPING ASSEMBLY (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R21	1-4	Same as R9				
	R22	1-4	RESISTOR, MF 511 Ω 1%, 1/2W	81349	RN65D5110F	620180	1
	R23	1-3	RESISTOR, MF 200 Ω 1%, 1/2W	81349	RN65D2000F	620070	1
	R24	1-3	RESISTOR, WW 50 Ω 3%, 3W	15915	TS2C	630220	1
	R24	4	RESISTOR, WW 250 Ω 3%, 3W	15915	TS2C	630280	1
	R25-27	1-4	Not Used				
	R28	1-3	RESISTOR, CC 4.7 k 5%, 1/2W	01121	EB4725	101511	2
	R28	4	RESISTOR, CC 4.7 k 5%, 1/2W	01121	EB4725	101511	4
	R29	1-4	RESISTOR, Var 500 Ω 10%, 1.5W	11236	1377438	600146	2
	R30,31	1-4	Not Used				
	R32	1-4	RESISTOR, MF 301 Ω 1%, 1/2W	19701	MF6C-D-2210F	102191	2
	R33	1-4	Not Used				
	R34	1-4	RESISTOR, MF 604 Ω 1%, 1/2W	81349	RN65D6040F	620210	1
	R35	1-4	Same as R6				
	R36	1-4	Same as R6				
	R37	1-4	Same as R29				
	R38	1-4	Same as R38				
	R39	1-4	RESISTOR, MF 124 Ω 1%, 1/2W	81349	RN65D1240F	620040	1
	R40	1-4	Not Used				
	R41	1-3	Same as R10				
	R42	1-4	RESISTOR, CC 2.2 k 5%, 1/2W	01121	EB2225	101454	1
	R43	1-3	Same as R10				
	R43	4	Same as R10				
	R44	1-4	Not Used				
	R45	1-4	RESISTOR, CC 82 Ω 5%, 1/2W	01121	EB1055	101445	1
	R46	1-3	RESISTOR, MF 2.21 k 1%, 1/2W	91637	DMF-65	101762	2
	R46	4	RESISTOR, MF 78.7 k 1%, 1/2W	81349	RN65D7872F	620757	2
	R47	1	RESISTOR, MF 18.2 k 10%, 1/2W	81349	RN65D1822F	620637	1
	R47	2	RESISTOR, MF 68 k 2%, 1/2W	81349	RN65D6812F	620749	1
	R47	3	RESISTOR, MF 100 k 1%, 1/2W	91637	MFF 1/4 T1	102206	2
	R47	4	RESISTOR, MF 100 k 1%, 1/2W	91637	MFF 1/4 T1	102206	1
	R48	1-3	RESISTOR, CC 6.8 k 10%, 1/2W	01121	EB6825	101510	1
	R48	4	Same as R28				
	R49	1-4	RESISTOR, CC 25 k, 1/4W			600364	1
	R50-51	1-4	Not Used				
	R52	1-3	RESISTOR, WW 500 Ω 3%, 1W	15915	TS2D	630338	1
	R52	4	RESISTOR, WW 500 Ω 3%, 3W	15915	TS1A	630340	1
	R53	1-4	RESISTOR, Var 5 k 10%, 1.5W	52542	600290	600290	1
	R54	1-4	RESISTOR, CC 4.7 M 10%, 1/2W	01121	EB4751	611135	1
	R55,56	1-3	RESISTOR, CC 10 Ω 10%, 1/2W	01121	EB1005	101632	2
	R55,56	4	RESISTOR, CC 5.6 Ω 5%, 1/2W	01121	EB5605	106016	2
	R57	1	RESISTOR, CC 220 k 5%, 1/2W	01121	EB2245	101458	1
	R57	2	RESISTOR, CC 330 k 5%, 1/2W	01121	EB3345	101457	1
	R57	3,4	RESISTOR, CC 680 k 5%, 1/2W	01121	EB6845	101504	1

Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

TITLE HRC SERIES SHIPPING ASSEMBLY (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R58,59	1-3	RESISTOR, CC 10 k 5%, 1/2W	01121	EB1035	101471	2
	R58,59	4	Same as R28				
	R60	1,2	RESISTOR, MF 100 k 1%, 1/2W	91637	MFF 1/4 T1	102206	1
	R60	3	Same as R47				
	R60	4	Same as R46				
	R61	1-3	Same as R46				
	R61	4	RESISTOR, MF 39.95 k 1%, 1/2W	81349	RN65D3995F	620700	1
	R73	1-4	Same as R8				
	R76,77	1-4	RESISTOR, CC 1 k 10%, 1/2W	01121	EB1025	101467	2
	R78	1-4	RESISTOR, CC 150 k 5%, 1/2W	01121	EB1545	101481	1
	R79	1-4	RESISTOR, CC 15 k 10%, 1/2W	01121	EB1535	101500	1
	R80	1-3	Same as R28				
	R81	1-4	RESISTOR, Var. 50 Ω, 1.5W	52542	600021	600021	1
	R82	1	RESISTOR, Shunt 15A	52542	T048551	T048551	1
	R82	2	RESISTOR, Shunt 10A	52542	T048552	T048552	1
	R82	3	RESISTOR, Shunt	52542	670022	670022	1
	R82	4	RESISTOR, Shunt	52542	T048555	T048555	1
	R86,87	1-4	RESISTOR, WW 150 Ω, 1.5W	52542	600071	600071	1
			OVERVOLTAGE ASSEMBLY				
		1	ASSEMBLY, Overvoltage	52542	PD25879	PD25879	1
		2	ASSEMBLY, Overvoltage	52542	PD25885	PD25885	1
		3	ASSEMBLY, Overvoltage	52542	PD25874	PD25874	1
		4	ASSEMBLY, Overvoltage	52542	PD25811	PD25811	1
		1-4	BOARD	52542	065448	065448	1
	C32	1-4	CAPACITOR, MF .1 μF 10%,250V	52763	MKT1813-410/25	800185	1
	CR41-43	1-4	DIODE, Rectifier 400V	04713	1N5395	100413	3
	CR44	1-4	DIODE, Zener 5.1V	03877	1N751A	100378	1
	Q30,31	1,2	TRANSISTOR, SIPNP 60V	04713	2N2905A	705067	2
	Q30	3,4	TRANSISTOR, SIPNP 60V	04713	2N2905A	705067	1
	Q31	3	TRANSISTOR, SIPNP	04713	MM4001	705066	1
	Q31	4	TRANSISTOR, SINPN	04713	MPS-A-92	700179	1
	Q32	1-4	TRANSISTOR, SIPNP	04713	2N2714	700180	1
	R100	1-4	RESISTOR, MF 1.96 k 10%, 1/2W	81349	RN65D1961F	620402	1
	R101	1-4	RESISTOR, WW 700 Ω 3%, 3W	15915	TS2C	630370	1
	R102	1-4	RESISTOR, CC 1 k 5%, 1/2W	01121	EB1025	101467	2
	R103	1-4	RESISTOR, CC 4.7 k 5%, 1/2W	01121	EB4725	101511	1
	R106	1-4	RESISTOR, Var 5 k 10%, 1.5W	52542	600290	600290	1
	R107	1-4	RESISTOR, MF 15 k 10%, 1/2W	01121	EB1535	101500	1
			AUXILIARY PC ASSEMBLY				
		1	ASSEMBLY, Auxiliary PC	52542	PD27673	PD27673	1
		1	BOARD	52542	128242	128242	1

Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

TITLE: HRC SERIES SHIPPING ASSEMBLY (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	C35	1	CAPACITOR, MF 300 μF,40V	52542	810184	810184	1
	CR47,48	1	DIODE, Rectifier 400V	04713	1N5395	100413	2
	R108	1	RESISTOR, WW 2 Ω 3%, 3W	52542	630060	630060	1
	R109	1	RESISTOR, CC 330 Ω 5%, 1/2W	01121	EB3315	101474	1
		1	ASSEMBLY, AC Harness	52542	PD2516301	PD2516301	1
		2,3	ASSEMBLY, AC Harness	52542	PD2528001	PD2528001	1
		4	ASSEMBLY, AC Harness	52542	PD2541301	PD2541301	1
		1	ASSEMBLY, DC Harness	52542	PD2516401	PD2516401	1
		2,3	ASSEMBLY, DC Harness	52542	PD2528101	PD2528101	1
		4	ASSEMBLY, DC Harness	52542	PD2541401	PD2541401	1

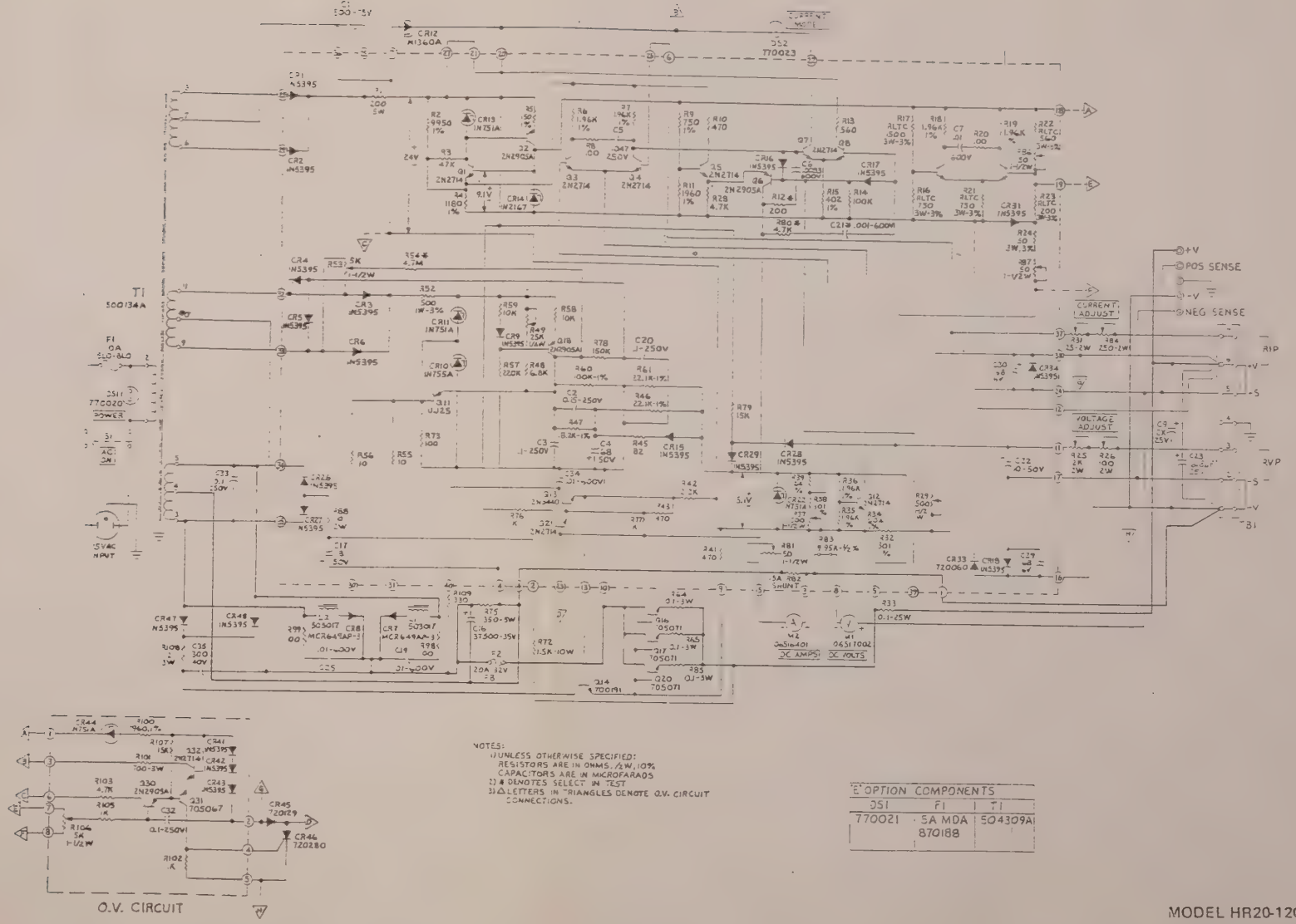
Used On Code: 1 = HR20-12COV 2 = HR40-10COV 3 = HR60-8COV 4 = HR160-3COV

CHAPTER 7

DRAWINGS

7.1 INTRODUCTION

This chapter contains the assembly and schematic drawings the for HRC SeriesMedium Power Half Rack Power Supplies. The schematic diagrams relate to the circuit details described throughout this manual. The parts list contained in Chapter 6 relate to the reference designation and item call-outs on the diagrams.

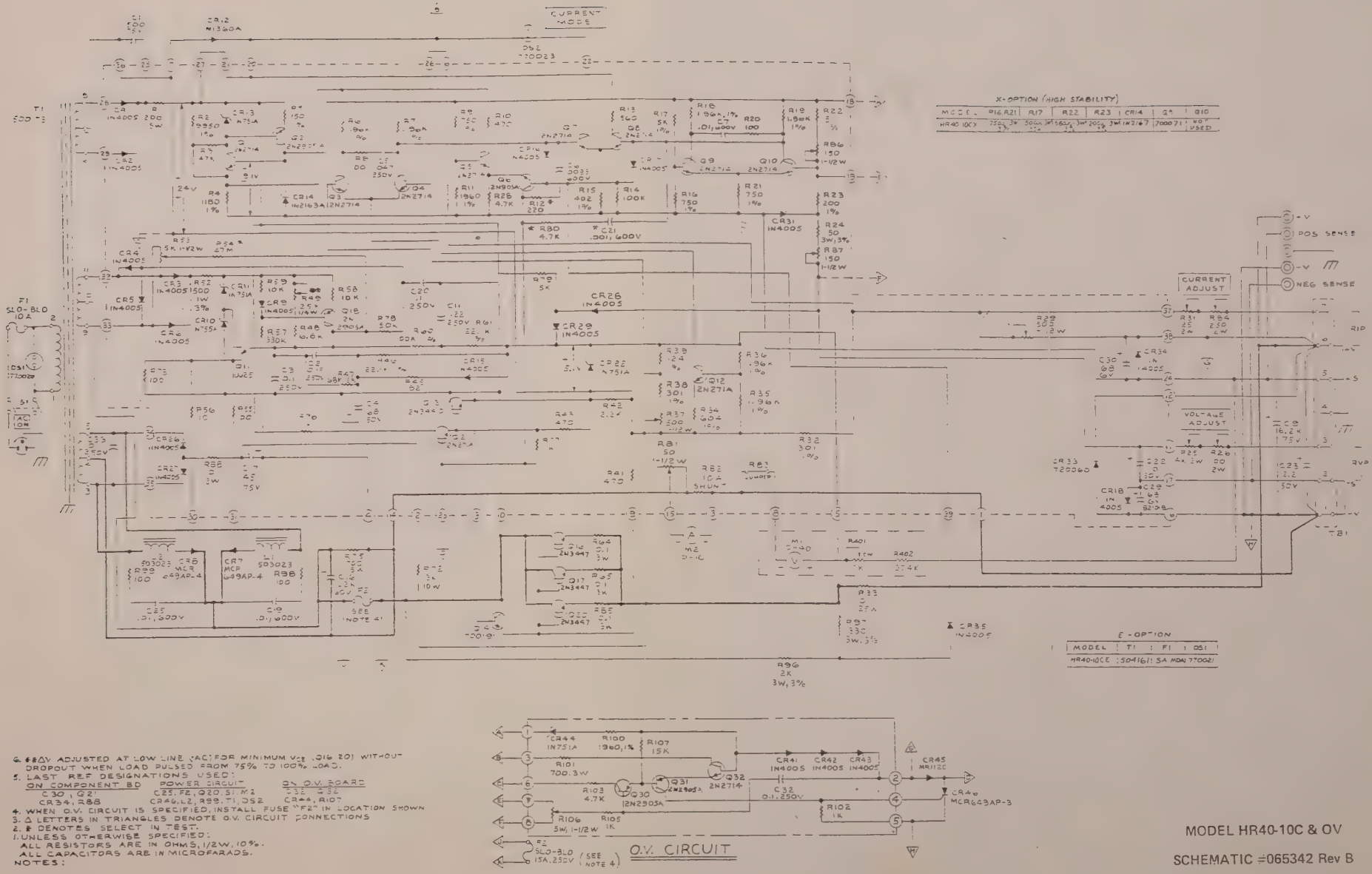


NOTES:
1) UNLESS OTHERWISE SPECIFIED:
RESISTORS ARE IN OHMS, ¼W, 10%
CAPACITORS ARE IN MICROFARADS
2) # DENOTES SELECT IN TEST
3) △LETTERS IN TRIANGLES DENOTE O.V. CIRCUIT CONNECTIONS.

E OPTION COMPONENTS		
DS1	F1	T1
770021	5A MDA 870188	504309A

MODEL HR20-12C & OV

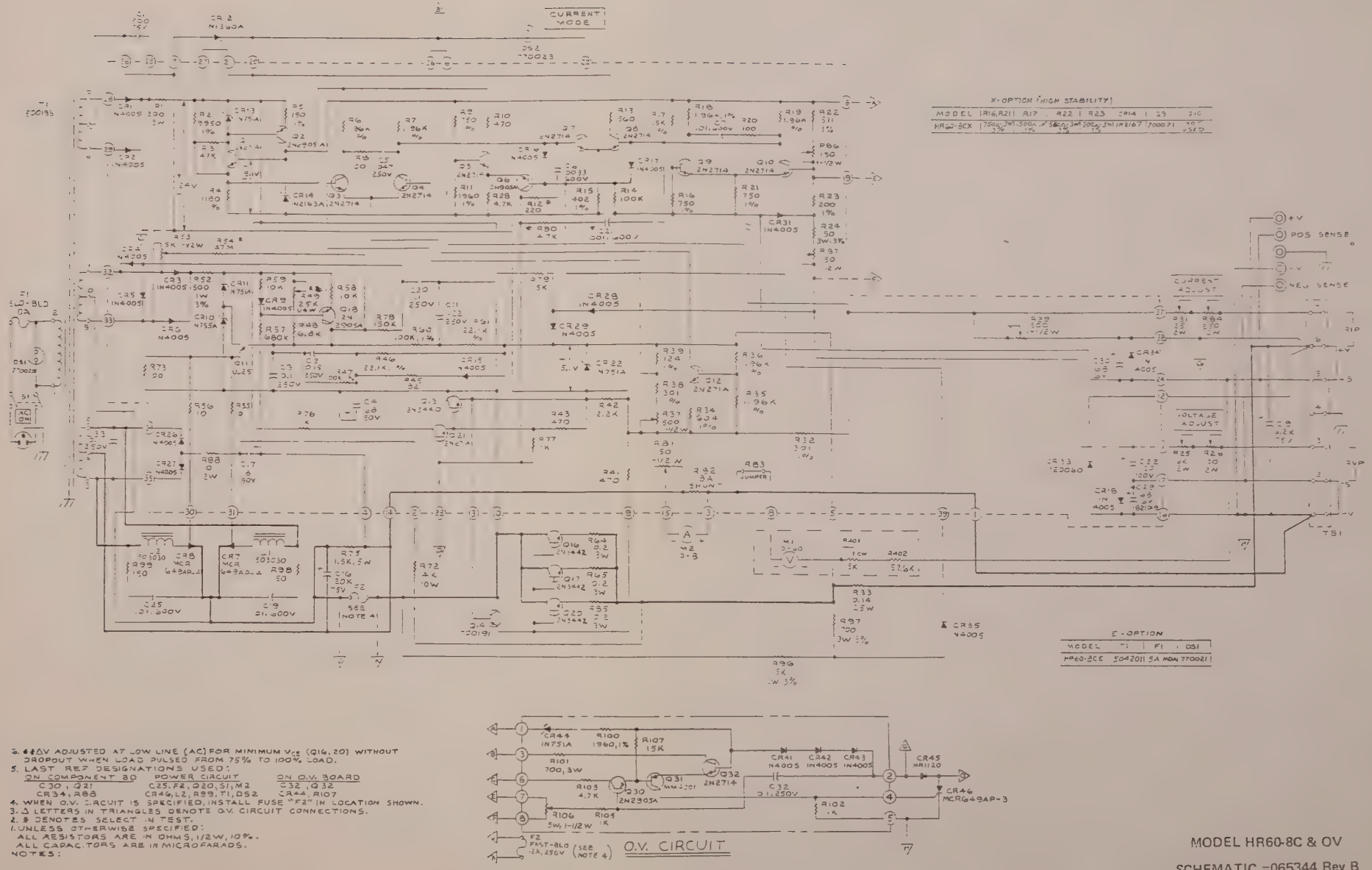
SCHEMATIC #128330 Rev B


CURRENT MODE
X-OPTION (HIGH STABILITY)
MODEL | R16,R21 | R17 | R22 | R23 | CR14 | Q9 | Q10
HR40-10C | 750Ω, 1% | 5.11K, 1% | 500Ω, 1% | 562Ω, 1% | 3W IN2167 | 7000711 | NOT USED
CURRENT ADJUST
VOLTAGE ADJUST
+V
POS SENSE
-V
NEG SENSE
E-OPTION
MODEL | T1 | F1 | DS1
HR40-10CE | 504161 | 5A MDA 7700211
O.V. CIRCUIT
MODEL HR40-10C & OV
SCHEMATIC #065342 Rev B

6. ΔΔΔV ADJUSTED AT LOW LINE (AC) FOR MINIMUM V_{CE} (.016, 20) WITHOUT DROPOUT WHEN LOAD PULSED FROM 75% TO 100% LOAD.
5. LAST REF DESIGNATIONS USED:

ON COMPONENT BD	POWER CIRCUIT	O.V. BOARD
C30, Q21	C25, F2, Q20, S1, M2	C32 Q32
CR34, R88	CR46, L2, R99, T1, DS2	CR44, R107

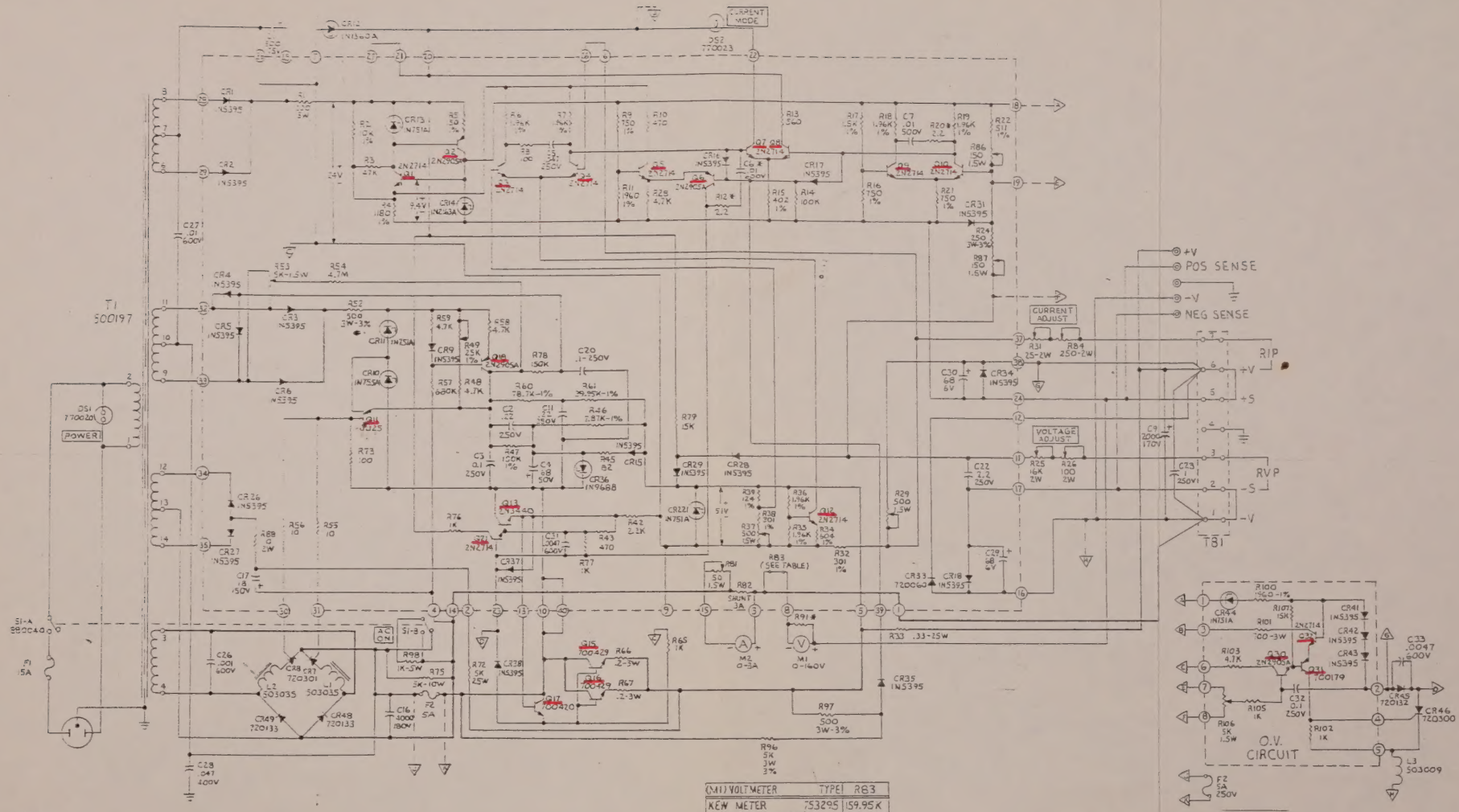
4. WHEN O.V. CIRCUIT IS SPECIFIED, INSTALL FUSE "F2" IN LOCATION SHOWN
3. Δ LETTERS IN TRIANGLES DENOTE O.V. CIRCUIT CONNECTIONS
2. ‡ DENOTES SELECT IN TEST.
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/2W, 10%.
ALL CAPACITORS ARE IN MICROFARADS.
NOTES:


CURRENT MODE
X-OPTION (HIGH STABILITY)
MODEL | R16,R21 | R17 | R22 | R23 | CR14 | Q9 | Q10
HR60-8CX | 750Ω,3W,1% | 500Ω | 5.6Ω,3W,1% | 500Ω,3W,1% | IN2167 | 700021 | NOT USED
E-OPTION
MODEL | T1 | F1 | DS1
HR60-8CE | 5042011 SA MDN 770021 | | |
+V
POS SENSE
-V
NEG SENSE
CURRENT ADJUST
VOLTAGE ADJUST
TRIP
EVP
TS1
O.V. CIRCUIT
MODEL HR60-8C & OV
SCHEMATIC =065344 Rev B

2. ⚡&ΔV ADJUSTED AT LOW LINE (AC) FOR MINIMUM V_{CE} (Q16,20) WITHOUT DROPOUT WHEN LOAD PULSED FROM 75% TO 100% LOAD.
3. LAST REF DESIGNATIONS USED:

ON COMPONENT BD	POWER CIRCUIT	ON O.V. BOARD
C30, Q21	C25, F2, Q20, S1, M2	C32, Q32
CR34, R86	CR46, L2, R99, T1, DS2	CR44, R107

4. WHEN O.V. CIRCUIT IS SPECIFIED, INSTALL FUSE "F2" IN LOCATION SHOWN.
3. Δ LETTERS IN TRIANGLES DENOTE O.V. CIRCUIT CONNECTIONS.
2. # DENOTES SELECT IN TEST.
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/2W, 10%.
ALL CAPACITORS ARE IN MICROFARADS.
NOTES:



NOTES:
1) UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, ½W, 5%
ALL CAPACITORS ARE IN MICROFARADS
2) *DENOTES SELECT IN TEST
3) LETTERS IN △ DENOTE O.V. CIRCUIT CONNECTIONS

750 3W-3%	1.5K 3W-3%	560 3W-3%	JUMPER 720139	700071 (DUAL)	NOT USED	HR160-3CX
R16 R27	R17	R22	R23	CR14	Q9	Q10	MODEL
FOR 'X' UNITS (ULTRA-HIGH STABILITY)							

MODEL HR160-3C & OV

SCHEMATIC #120010 Rev H

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